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Building a Virtual Hospital

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Abstract **- This paper is about electronic services in healthcare. I begin by providing a virtual organisation model that contains four variables: connectivity, purpose, technology and boundary. Based on the model, some predictions for the stability of virtual organisations can be done. The theoretical part is followed by a real-life example of a virtual hospital. The focus is on finding and naming the four variables of the virtual hospital. Furthermore, the barriers and benefits of development of the virtual hospital are discussed.**

I. Introduction

The late 1990's has been a time of restructuring for healthcare, especially public health care in Finland, where traditionally more than half of the health care services are provided by public funding, and where the economic efficiency has not been the primary issue in health care activities [1]. However, the challenge of the following decades will be a demographic change which means a growing number of elderly people and therefore an increasing need for health care services [2][3]. This places pressure on the Finnish public health care finances, which leads to the pressure to cut down the costs both in operative care and administration. Furthermore, quality issues and rapid technological changes are increasing the pressure at the same time as the private sector has intensified competition [5]. The answer to these challenges is thought to be found in information technology, especially in Internet-based information systems, which could help to reorganise the customer care routines and the services offered in a more efficient way.

Nowadays use of the Internet within medical practice is growing rapidly. A study made by Healtheon Corporation, published in May 1999, estimated that 85 percent of US physicians were Internet users (42 percent increase within the past three months), which accounts for an 875 percent increase since 1997 [4]. Two thirds use e-mail daily and a third use e-mail for communicating with patients. However, 34 percent of doctors surveyed expressed strong concern about security issues and almost half of the doctors identified the time need for Internet adoption as a stumbling block.

Another study by PSL Research estimated that by October 1998 44 percent of physicians world wide had accessed the Internet and the number was expected to rise to 64 percent by spring of 1999 and 78 percent shortly after [4]. The study was conducted in the spring and summer of 1998 in two parts of which the first was a telephone survey of 1,103 physicians in eleven countries, and the second was a questionnaire answered by 2,532 physicians in 105 countries. The physicians surveyed were experienced Internet users.

According to PSL Research the Web was used for information retrieval concerning diseases, accessing medical journals, visiting medical association sites, consultation with colleagues in their own country and abroad, and for insurance and billing claims.

In Britain a recent research by NOP has also shown that among British GPs the primary motivation for going online is to access the most recent clinical information available, such as the British Medical Journal and Medline [4]. In addition GPs use the Internet to communicate to patients and vice versa, with some GPs receiving up to 40 e-mails a day from patients.

It seems that health-related services are beginning to proliferate on the Web, ranging from the simple version of sponsored information to the actual delivery of health services and products. However, the study made by the HON foundation in March-April 1999 shows that experienced users feel that the quality of health and medical information available online needs to improve [6]. This is stated even though one third of users from outside the medical profession have no opinion on the quality of the information available online [6].

As a result of the information and communication needs that both doctors and customers face nowadays, many companies and healthcare organisations in Finland have decided to implement different kind of information systems to support information searching, acquisition and transfer. One of those projects is a medical Internet consultation service and health care network, in other words virtual hospital that enables patients to contact the doctors in secure way via the Internet.

In this paper I examine the development and implementation phases of the virtual hospital and compare it to a model of virtual organisations presented by Shao et al. [8]. The aim of

the paper is to examine if the four variables of the model of virtual organisation can be found from the empirical case study and be applied to the virtual hospital context. I also discuss the barriers and benefits we have come across when implementing the virtual hospital.

The case example presented is based on my experience gained when being involved with the development of the virtual hospital. My primary task has been to find out how the public health centres would benefit from the virtual hospital and to present the virtual hospital concept to the doctors working there. However, I have also done overall evaluations of the virtual hospital concept as part of my research on healthcare information systems. These evaluations are mainly based on the theory of virtual organisations and electronic commerce in healthcare, as also presented in this paper.

II. A VIRTUAL ORGANISATION

A. *Definition of virtual organisation*

The virtual organisation, sometimes also described through terms of virtual corporation or the virtual office, was seen already about 20 years ago, when working at home was made possible by using the technology [9][10][11]. In those 20 years, the virtual organisation is defined in almost as many ways as there are papers written about it. The main expressions related to the virtuality are "at any time" and "at any place". More sophistically Harrington describes that the virtual organisation is related to a conceptual organisation which is "*abstract, unseeing and existing within the minds of those who form a particular organisation*" [12].

Furthermore, Moshowitz has written that virtual organisation can be characterised by

1. a specification of abstract requirements,
2. the tracking and analysis of concrete satisfiers for each abstract requirement,
3. the dynamic assignment of concrete satisfiers to abstract requirements on the basis of explicit (bounded-rational) criteria, and
4. a continuous exploration and analysis of the assignment criteria associated with the goals and objectives of the organisation [7].

However, nowadays the most common way of defining virtual organisation is done in terms of information technology. This means that the organisations are built up by virtual links by using IT [8]. A virtual organisation can be seen as distributed organisational units supported and connected by information technology, which take part in a shared, co-ordinated business process [16]. These organisational units work together without drawing strict borderlines and even independent of time and space. This is also the case in the virtual hospital presented later in this paper.

B. *A model of virtual organisation*

Shao, Liao and Wang have presented a model of virtual organisation both for new and existing organisations. The model contains four variables: connectivity, purpose, technology and boundary [8].

Connectivity, which is the first characteristic of a virtual organisation, enables physically separated people to interact without time or distance constraints. Employees who are not co-located in the same physical place, but who work together for a (virtual) company, become part of a virtual office. The same way customers, who do not visit a physical building, but receive goods and services through e.g. Internet connection, also become associated with a virtual business.

The connectivity has to be looked both in terms of selectivity and difficulty. Selectivity describes how important the connectivity is for the success of virtual organisation and difficulty how hard that connectivity is to achieve. Evidently, selectivity will foster a virtual organisation where as difficulty will hinder it.

Purpose answers the question of what benefits can be gained from a virtual organisation arrangement. This is the issue of value of the virtual organisation. Purpose can for instance be defined in means of space savings, cost reductions or better customer satisfaction and together with connectivity, purpose describes the benefit side of the virtual organisation. Perhaps needless to say that purpose is the basic drive for virtual organisation creation – the stronger the purpose, the more selective the arrangement of a virtual organisation.

Technology is an enabler of virtual organisations. Shao et al. [8] have listed three technologies that play significant roles in virtual organisations:

1. Telecommunications
2. Databases
3. Multimedia

Telecommunications offer an opportunity to work at any place and databases provide an organisational memory and make time irrelevant for virtual organisation employees. Multimedia, which includes features such as animation, video and audio, creates a virtual reality through picture and sound for an employee or customer. However, technology will also in some cases hamper adoption of a virtual organisation, especially if the technologies used are complex and expensive.

Boundary is created to separate those who are part of the virtual organisation from those who are not. Even though the physical boundaries become meaningless in a virtual company, the idea behind it is the same. Boundaries are built to ensure that the outsiders cannot derive benefits that they are not entitled to. With the advancement of technology, boundaries of a virtual organisation have become both stronger and, at the same time, less visible. Shao et al. claim that "*The invisibility of virtual organisation would be one of the important indicators to measure the virtuality of the organisation.* " [8].

Shao et al. [8] believe that these four characteristics can give guidance for the assessment of virtual organisation stability. According to them the most stable type of organisation is the

one that has high connectivity, high purpose, high boundary and high technology. Logically, the least stable form of virtual organisation is the combination of low connectivity, low in purpose, low technology and low boundary. This way the characteristics can be used, not only in analysing different virtual organisation cases, but also to predict for their stability.

III. ATULINE – VIRTUAL HOSPITAL

In autumn 1998, a small Finnish company decided to build a medical internet consultation service and health care network that enables patients to contact expert clinicians around the world. The original idea was to target the service at those people who may have difficulties in getting medical advice in their own language e.g. citizens resident in a foreign country and travelling business people. Other important subscribers are deaf people, who find spoken consultations difficult, large corporations and travel insurance holders. However, there are situations in which also public health centres will benefit from using an Internet-based consultation service. It is thought to be useful in areas such as Finnish Lapland where the distances are long and the nearest doctor may be situated hundreds of kilometres away from his/her patients.

The virtual hospital was created in close co-operation with national health care authorities, because the practice of medicine is a highly regulated business and in order to be able to answer the various questions that raise from licensure requirements to efficacy of care, the consultations of different authorities is needed. As result, in autumn 1999 the virtual hospital was recognised as a private health care provider in Finland.

A. The structure of the virtual hospital

Practically the position of a private health care provider means that the service provider, Multimedica Oy (Ltd.) (see Fig. 1), is responsible for collecting official documentation that ensures all experts are licensed to practise as medical doctors. It also manages the legal and insurance issues, as well as the recruitment of medical experts. Legal issues concern the need to check that medical experts are licensed to practise in their own countries, and to solve the question of liability when giving consultations across state borders [13]. The service provider also supplies the technical facilities of the virtual hospital.

Internet consultations often lead to the need for physical examinations or treatments, which naturally cannot be provided via the Internet. Therefore a network of healthcare facilities will be created to provide members with the possibility for referrals to physical medical establishments.

However, the network of hospitals and health centres is only available for registered members. To register to use the service, customers must pay a subscription fee and give some medical details such as height, weight or regular medication. Once registered, patients can receive medical and general advice. Subscribers are then given an information card, which identifies them as members if they need to visit physical hospitals or other health care facilities, which are part of the network. No prescription is yet given on-line, as the electronic prescription is still under development and testing in Finland.

General practitioners (GPs) can also be seen as registered members, and they can use the service for consultations with specialists. In this way, the virtual hospital can be used for doctor-to-doctor consultations. Medical experts also have an access to all value add services, such as information and best practices databases, provided by Atuline.

Unregistered members are not able to store medical information or link previous consultations together. Neither do they have the information card that provides the services of healthcare facilities network. Patients are also usually asked to register when using the services on a regular basis, because the nature of services demands user identification. Furthermore by registration customers can be rewarded for disclosing information about themselves i.e. customers get some value in exchange for information [15][14]. Still there can be some

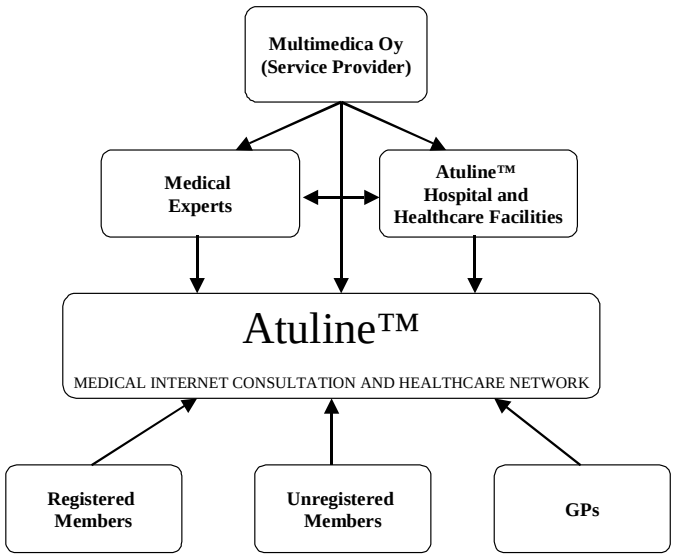

Fig. 1. The structure of the virtual hospital

situations (e.g. related to HIV and other venereal diseases) in which the services are provided to unregistered patients who are willing to remain anonymous [13].

B. Value added services

The virtual hospital provides some added value services both to doctors and patients. The medical experts have an access to several databases such as DLI (Drug Laboratory Interference knowledge base) and DI (Drug Interactions database) as well as Finnish best medical practices database. The patients will be provided self-care information, but no information database is yet established. The challenge in self-care information is not to offer any kind of harmful or incorrect information for people outside of the medical profession as they may not have the knowledge to judge the rightfulness of the information they are using.

C. Technology

The system is built on a web page interface, which is applied throughout the system. The use of Internet allows any-place access, which is a vital feature of the virtual hospital concept. Having logged into the system. a subscriber requiring medical advice can either upload their own text document or enter text into a text field. They can also refer to the previous consultations shown on the web site or use the information services and databases offered by the virtual hospital.

The original take-off for the virtual hospital was an idea to replace the unprotected e-mail consultations that seem to be ever more popular among the GPs. Therefore, in virtual hospital much emphasis is placed on adherence to data security and confidentiality issues. Atuline uses the same technology as Internet banking systems in Finland, which means that in general, the information is encrypted through a SSL (secure socket layer connection) [13]. SSL offers secure transmission of text, images, video and sound. The whole system also includes other layers of security and sophisticated encryption that protects from intrusion. It prevents anyone from gaining unauthorised access.

Personal security options depend on the subscriber group. Security and identification can be subscriber defined: The subscriber is given a list of unique passwords to access the virtual hospital system. Each password can only be used once before it expires, then the next password on the list must be used. For security reasons consultation replies are not emailed to users, but notice of reply may be sent by email or to a GSM phone alerting the user to the fact that the reply is available from the Atuline server.

In addition to establishing secure methods for the transmission of medical information, also secure payment systems have been implemented. The subscriber can either pay the consultation by using one of the Scandinavian Internet banking systems or SET-based credit card payments.

In this way, Atuline has built different levels of boundaries to both its customers and employees.

TABLE 1.
THE SUMMARY OF THE VARIABLES RELATED TO A VIRTUAL HOSPITAL

Purpose	Creation of a medical internet consultation service and health care network. Building an easy access to information databases such as best medical practices, DI and DLI.
Connectivity	Creation of a health care network that connects certain hospitals, health centres, clinical laboratories and pharmacies to offer services that cannot be performed over the Internet.
Technology	Telecommunications and the Internet allow any-place access. Emphasis on data security and confidentiality issues to prevent unauthorised use.
Boundary	Data security options prevent unauthorised access to the virtual hospital. At the same time the web-based system serves as an easily accessed and wide medium for access by authorised members and medical experts.

IV. DISCUSSION ON THE VIRTUAL HOSPITAL CONCEPT

The virtual hospital has almost finished both its technical and administrative development phases and it will be opened for the public in the beginning of December 1999. The administrative part has been the challenging part of the project. There are several reasons for that. First of all, the concept of virtual hospital is rather new and Atuline was the first one to provide health care consultation only in the Internet in Finland. Therefore there were no previously made regulations or decisions that could have been applied to the virtual hospital concept. Regulators and government decision-makers had to, one-by-one, decide what kind of approach they apply when dealing with the virtual hospital. A negative appraisal for example from the Office of Data Protection Ombudsman in Finland, could have changed, if not even break up, the whole project [17][18]. Fortunately, the regulators answered in the affirmative, although there are certain barriers and worries that they stressed.

Barriers arise from legal and regulatory issues unique to healthcare, including privacy regulations, licensing and liability, and malpractice laws. Licensing and liability laws may impact health care providers' willingness to practice medicine in Internet even though all experts providing consultation services through the virtual hospital are fully insured for medical practice by the service provider. In addition in some countries, like Germany, there are very strict regulations that conduct the consultations given over the net.

In the virtual hospital the consumers' rights have to be considered carefully. Medical consultations can be considered

credence goods meaning that consumers may have difficulty evaluating the quality of service even after it is experienced [19]. Therefore the authorities, e.g. in Finland, have decided to strongly support the customer in conflict situations between electronic service provider and customer [21].

To approve the quality of services the virtual hospital will have to accept that the consultations can only take place when physical examination of the patient is unnecessary.

It also has to be remembered that when working in the European level, the differences in culture and languages, as well as licensing and liability regulations may affect the interactions between doctors and patients even though the medical knowledge itself is basically the same in every country.

There are also worries that Internet-based clinical services will open doors to increased probability of misuse of the health care services as well as patients faking an illness in order to obtain prescription drugs [19]. Therefore, a decision was made by Atuline not to prescribe drugs like sleeping pills, sedatives or certain antibiotics as a result of Internet consultation [20]. On the other hand, it has to be remembered that faking an illness is not that difficult in a traditional way of medical consultation either.

In spite of these significant barriers, which have to be taken into serious consideration before launching the virtual hospital, health care e-commerce does offer considerable opportunities.

In addition to any time and any place access to the system, the virtual hospital gives benefits in terms of information sharing. Patient record database and information services that can only be accessed through the virtual hospital web page help to avoid scattering of information and allow rapid movement of it [23]. In simple terms, the same system which doctors use for consultations is also a medium to gather, file and transfer the patient records [22]. This can facilitate information sharing among doctors and health care organisations to improve overall co-ordination of services as well as helping patients navigate through the complexity of the current health care system. The easy transfer of information also enables doctor-to-doctor consultations, in which i.e. GPs can ask 2nd opinions from other experts. Patient records can easily be transferred from one doctor to another, although permission to transfer is still needed from the patient. In addition the patient's side of the conversation will also be stored, unlike in traditional consultations where the patient records are based on doctors' notes and memory. The Internet gives the possibility to digitalise the content of service for further use, which means that service conducted through the virtual hospital can be reused if needed.

The other important feature of the virtual hospital is the information services provided especially for doctors. In future healthcare, as in other businesses as well, it is ever more important to be able to absorb relevant information from a huge flow of information of all kinds [22]. There are already signs that the demand for clinical knowledge already outstrips supply and the consequences of this inequity are beginning to be reported [24]. In the virtual hospital doctors have greater access to information and services, especially those not readily available in their homes or offices via traditional means.

Looking from the patient point of view, the virtual hospital has arouse great interest in certain patient groups that prefer the web interface instead of traditional face-to-face interaction with a doctor. These specific groups are, for instance, deaf and disabled people, who otherwise would need an interpreter or transportation to the health centre, people living at distant areas and those ones that are ashamed to go a doctor.

Also the decisions makers at the healthcare sector have seen the opportunity for cost savings in the virtual hospital concept. It is estimated that a web-based interaction will replace some of the appointments to a doctor or visits to a hospital [20]. There are already similar findings from NHS Direct, in England, which is a new 24-hour telephone advice line staffed by nurses. The overall aim of NHS Direct is to provide "*easier and faster information for people about health, illness and the NHS so that they are better able to care for themselves and their families*" [25]. The surveys done about NHS Direct clearly show that it has reduced the need for doctor appointments: *"… 31% of callers were given advice on how to look after themselves at home compared with only 11% who thought they needn't leave home before they called NHS Direct.* [25]*"* In addition 40% of callers were advised to seek less urgent care than they intended [25]. Similar types of results have thought to be found from the virtual hospital case in the future [20].

V. Conclusions

In this paper I have discussed the Atuline virtual hospital and if it fits to the model of virtual organisations presented by Shao, Liao and Wang [8]. The main characteristics of the model are connectivity, purpose, technology and boundaries. In the virtual hospital the connectivity is ensured by implementing a web-based interface, which allows access to the system and its services without time and place constraints. In a way that is also the purpose of the virtual hospital: creation of a medical Internet consultation service and healthcare network, which can be reached world widely. At the technological side much emphasis is put to the privacy and data protection. Encryption and user identification ensure that only authorised members can access the system and this way the boundaries are built between the members of Atuline and other Internet users.

In my opinion the variables of virtual organisation can be found from the case of the virtual hospital and the virtual organisation model can be applied to this case. At the moment, when the virtual hospital concept is still fairly new, it seems to have all the four characteristics: high connectivity, high purpose, high technology and high boundary, which would, according to Shao et al., indicate stability of the organisation. However, since the venture is only in the beginning, very far-reaching conclusions about its stability cannot be derived. In addition, it has to be remembered that not only certain list of found characteristics make the virtual hospital concept approved, but also the potential barriers and benefits of the new organisation has to be considered. In this case, the major

barriers and worries arise from the nature of the service, which demands careful information handling and responsibilities in terms of giving consultations without seeing the patient, transferring the private healthcare information on the net and storing it to the databases accessed through a web interface. The benefits are mainly related to the possibility to access the system and its services without time and place constraints.

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